




Agriculture and  
Agri-Food Canada

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# Monitoring and Assessing Drought and Drought Impacts in Canada

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National Agroclimate Information Service  
Agriculture & Agri-Food Canada

North American Drought Monitor Forum  
April 18-20, 2012

Canada 



# Presentation Outline

- The National Agroclimate Information Service
- Challenges in Drought Monitoring in Canada
- Advances in Canadian Monitoring Activities
  - The Canadian Drought Monitor
  - Network Density / Accessing Additional Data Networks
  - Monitoring in the Northern (Forested) Regions of Canada
  - Use of Remote Sensing
  - The Agroclimate Impact Monitoring Network and the Agroclimate Impact Reporter (AIR)



# The National AgroClimate Information Service (NAIS)

## NAIS has the majority of climate expertise within AAFC ...

- Develops and integrates agro-climate expertise
  - from research to policy to operational
- Works with a wide range of partners
  - ag sector, within AAFC, OGDs, provincial government, academia, private sector
- Provides information and tools to manage risks under climate variability now and in the future.
  - Monitoring weather and agroclimate impacts
  - Developing adaptation tools for risk management and decision support.

Monitoring of extreme weather and climate is increasingly important to agriculture, and the incidence of extreme weather is expected to increase.



# Focus is climate-related risks to agriculture ...

## **1. Assess climate-related risks to the agriculture industry**

- Timely Climate Monitoring at National & Regional Scale

## **2. Improve adaptation to climate-related risks**

- Yield forecasting
- Drought preparedness and planning
- Vulnerability of systems to climate variability (e.g. watersheds)

## **3. Data acquisition, development, web applications and web based delivery**

- Help to identify probabilities, frequencies and potential changes in climate trends and extreme event patterns
- Improved usage of remote sensing and other related information to assist in monitoring

## **4. Analysis to support climate change adaptation**

- Support to policy



# Agroclimate Monitoring

- NAIS collects climate data from a variety of national, provincial and local networks from across the country and provide information products on a daily basis.



**[www.agr.gc.ca/drought](http://www.agr.gc.ca/drought)**

**Over 500 maps produced  
every weekday**

## **Products include:**

- **Seasonal and Annual Products**
- **Rolling Time Frames for various precipitation indicators (7-day out to 1 year)**
- **Dry Spell indicators:**
  - - 7, 14, 30, 60... days with < 0.5 mm
  - - Consecutive days with < 0.5 mm
- **Temperature**
  - - Max/Min temperature over 7-days
  - - Heat waves
- **Growing Degree Days (Base 0, 5, 10, and 15)**
- **Corn Heat Units**



# Canada's Involvement in NADM

- Initially Canada was only assessing the agricultural areas and only in English (2002).
- Added French version in November 2003.
- Added northern regions of the prairies in the spring of 2004.
- Later in 2004 Areas outside the agricultural regions were added for other part of the Canadian Provinces.
- We have still not added the northern territories.

## North American Drought Monitor

January 2004

Released: Friday, February 27, 2004

<http://www.ncdc.noaa.gov/nadm.html>

Analysts:  
Canada- Ted O'Brien  
Dwayne Chobanik  
Mexico- Miguel Cortez  
U.S.A.- Mark Synoboda  
Michael Hayes  
(\* Responsible for collecting analysts' input & assembling the NA-DM map)

**Drought Intensity:**  
D0 Abnormally Dry  
D1 Drought - Moderate  
D2 Drought - Severe  
D3 Drought - Extreme  
D4 Drought - Exceptional

~ Delineates dominant impacts  
A = Agriculture  
H = Hydrological (Water)  
(No type = Both impacts)



Experimental

## North American Drought Monitor

April 2004

Released: Friday, May 21, 2004

<http://www.ncdc.noaa.gov/nadm.html>

Analysts:  
Canada- Ted O'Brien  
Dwayne Chobanik  
Mexico- Miguel Cortez  
U.S.A.- Chester Schmitt  
Douglas Le Conte  
(\* Responsible for collecting analysts' input & assembling the NA-DM map)

**Drought Intensity:**  
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A = Agriculture  
H = Hydrological (Water)  
(No type = Both impacts)



Experimental

## North American Drought Monitor

January 31, 2008

Released: Friday, February 22, 2008

<http://www.ncdc.noaa.gov/nadm.html>

Analysts:  
Canada- Trevor Hansen  
Dwayne Chobanik  
Mexico- Valentina Davydova  
Adelina Escamillon  
Elvira Delgado  
Fernando Romero  
Douglas Le Conte  
(\* Responsible for collecting analysts' input & assembling the NA-DM map)

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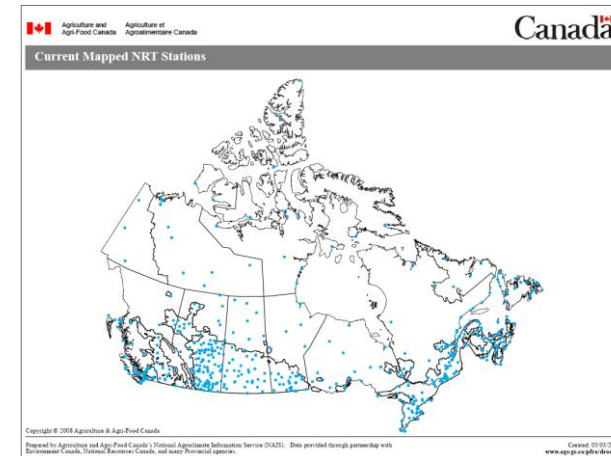
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text for a general summary.

Regions in the northern extremes of Canada may not be as accurate as other regions due to limited information.



# Challenges for Drought Monitoring in Canada

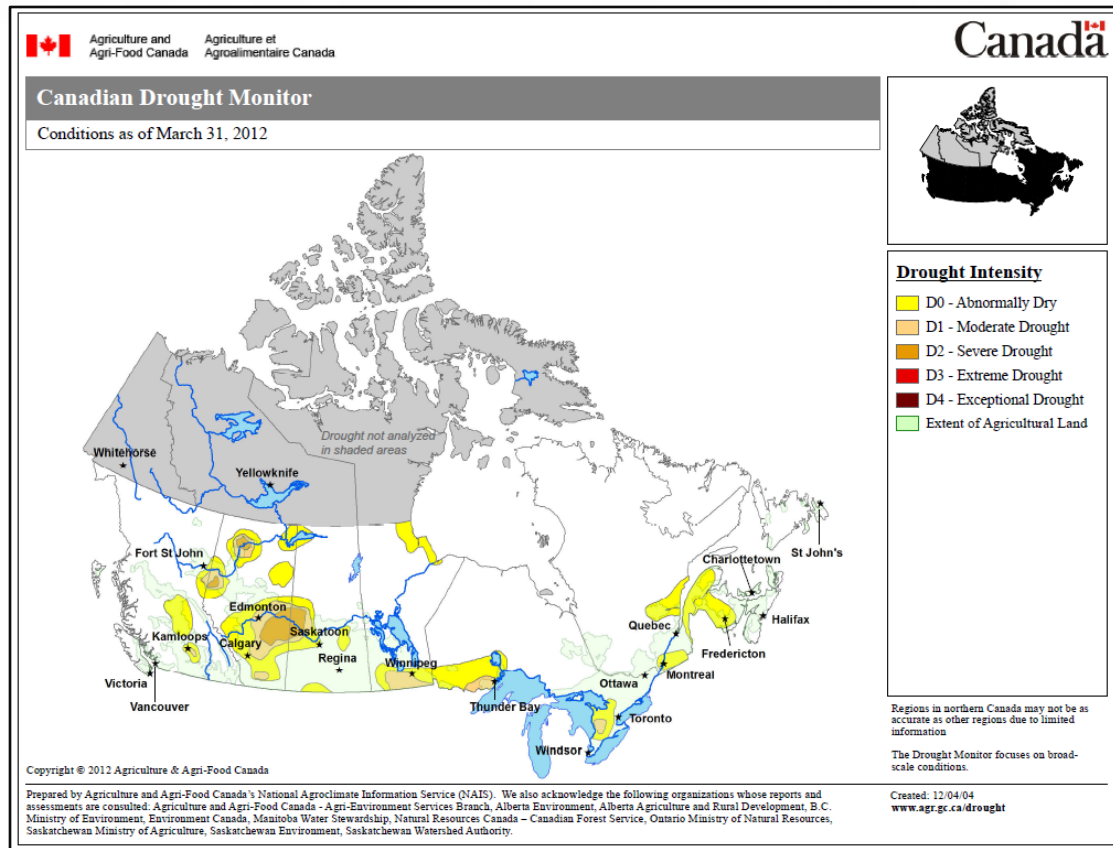
- Canadian environment is complex and drought indices need to be utilized in a way that reflects the regional differences.
- Quality and quantity of data is poor/incomplete. Data density and length of record are both significant challenges.
- Winter often puts a hold on drought impacts but not necessarily the drought. Indices/indicators do not account for this.
- Snow is hard to measure, it tends to move around before the moisture is accessible (Blowing, runoff, sublimation).
- There is also limited climate data and other drought information during the winter season.



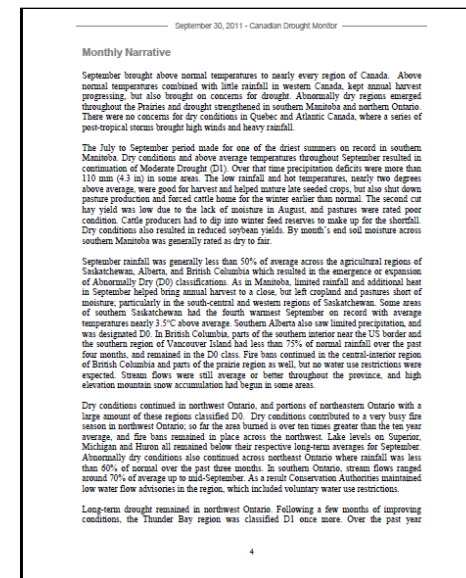


# The Canadian Drought Monitor

- In 2009, we experimented with the development of a Canadian Drought Monitor in conjunction with our work with the NADM as a proof of concept.









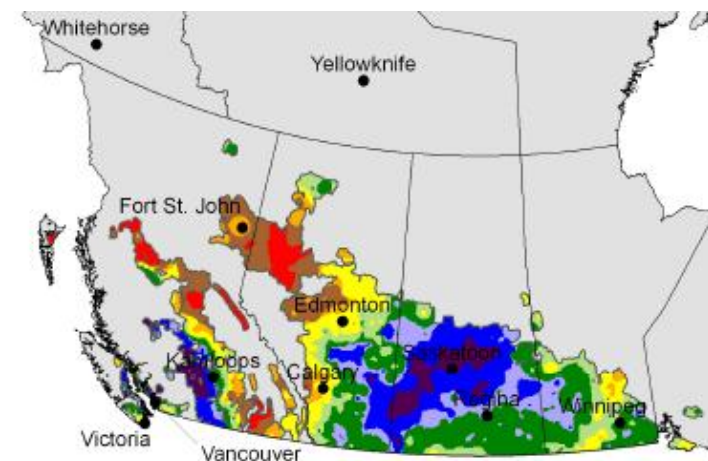
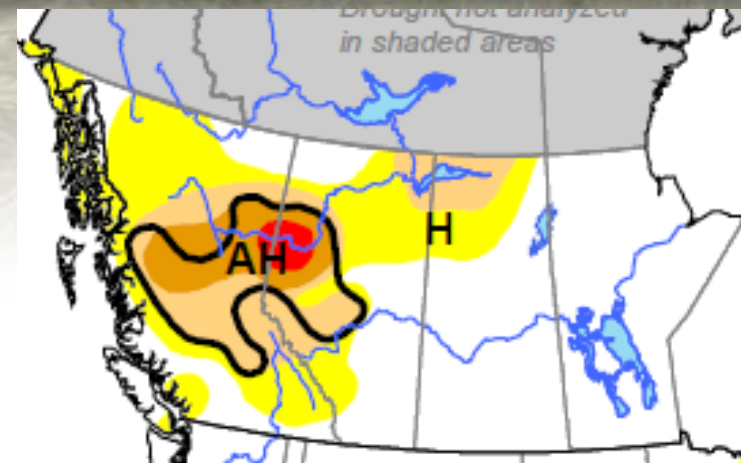
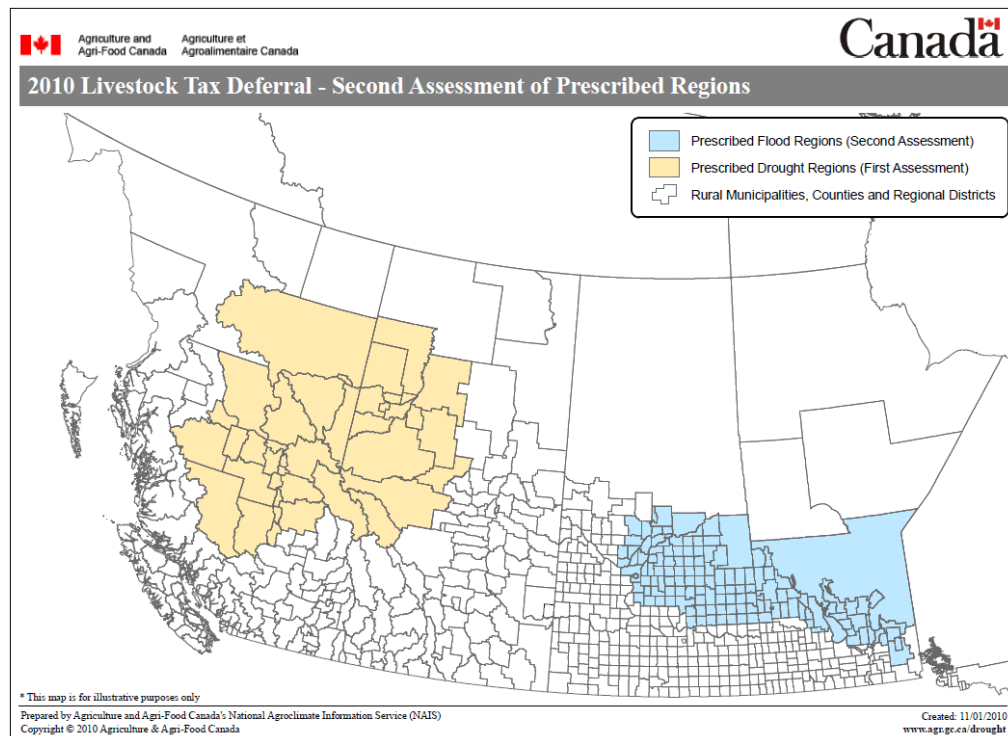
# Results of Developing the Can-DM

- Very positive reaction, even though in the past couple years Canada has not experience significant widespread drought.
  - The Canadian version of the Drought Monitor is appearing in provincial and regional documents and reports, as well as limited interest from the media.
  - Provincial agencies have become more involved
- Up until now we have not had the ability to post this material to our website which has hampered our ability to reach more of an audience.
- We will be developing a website in the near future to host this information.



# Can-DM in Agriculture Programs and Policy

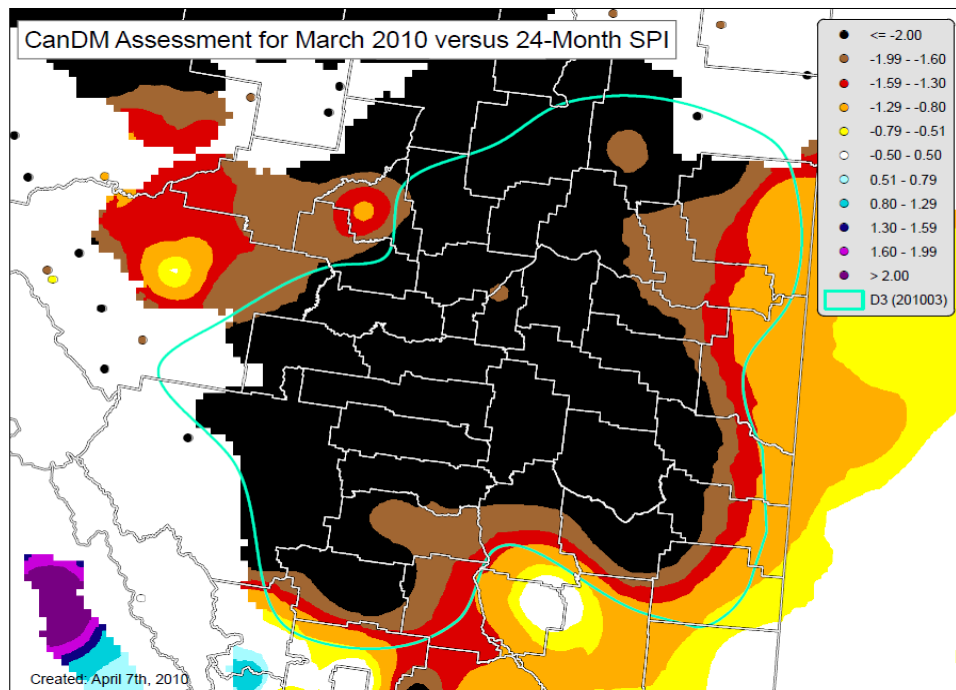
Can-DM is used as part of a suite of indicators for the assessment of the Prescribed Drought Regions for Livestock Tax Deferral.





# 2010-11 Pasture Recovery Program

- The Canadian Drought Monitor was used to develop an emergency assistance program for cattle producers who were being significantly affected by long term drought conditions.



Saskatchewan

\$16,878,007

Alberta

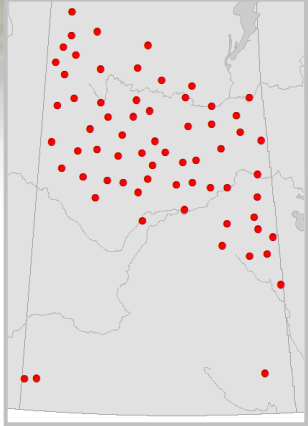
\$67,183,973



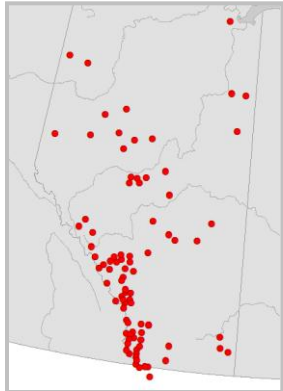


# Distribution of Our Real Time Data Network

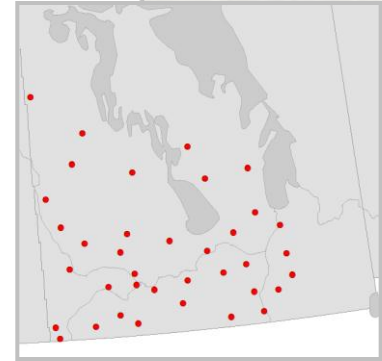
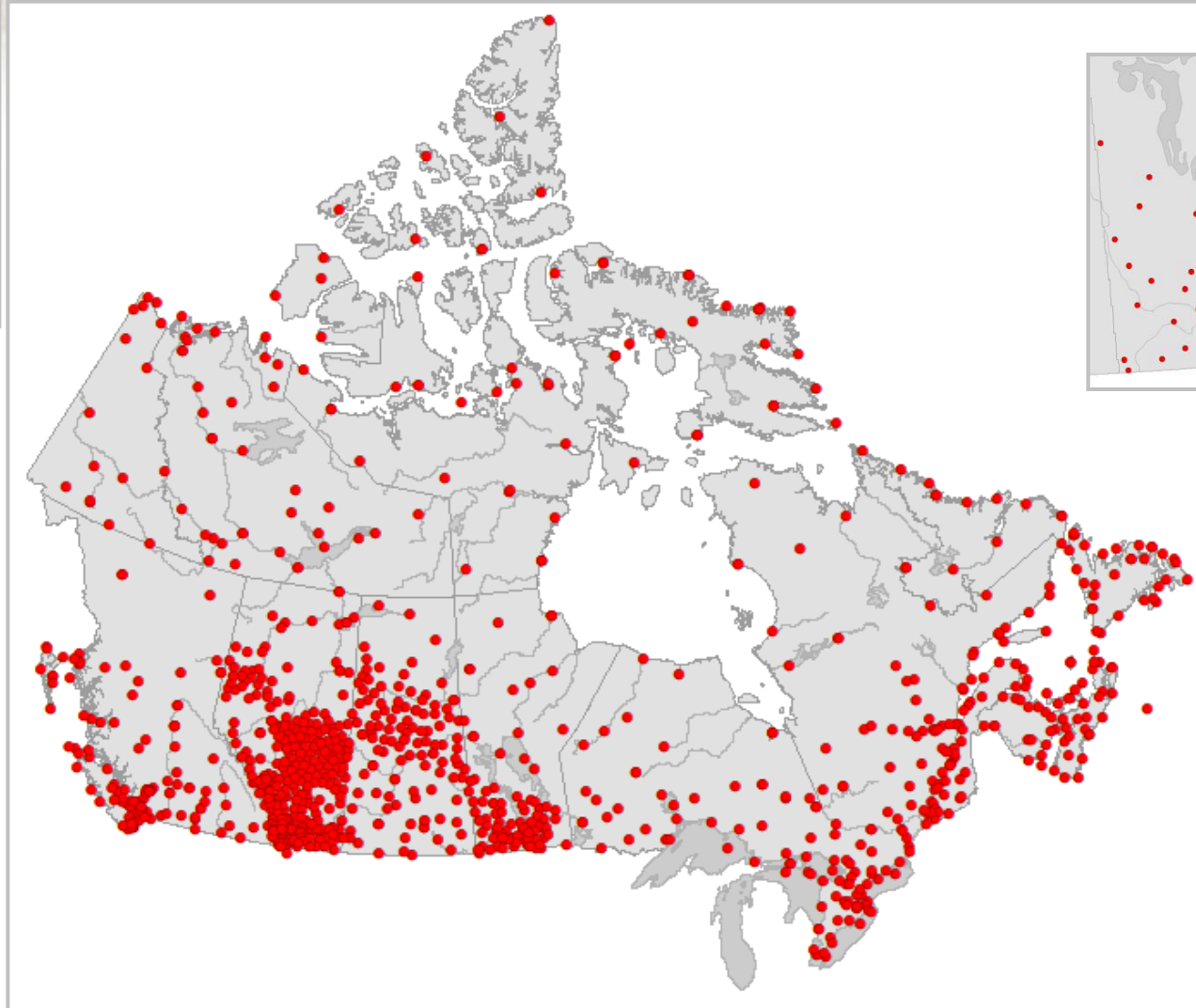
## Near Real Time Network



SK Env



AARD

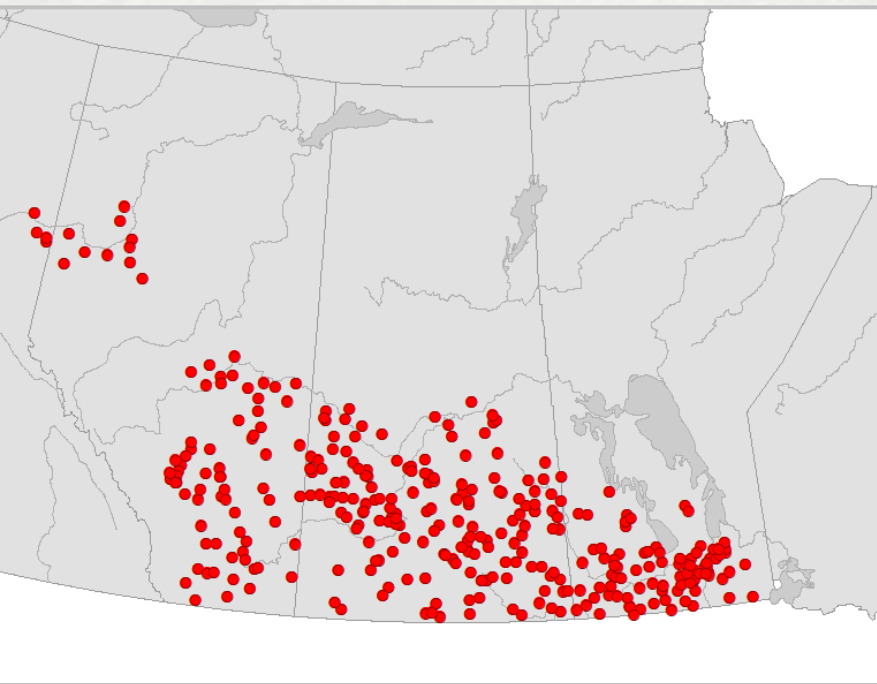


MB Ag

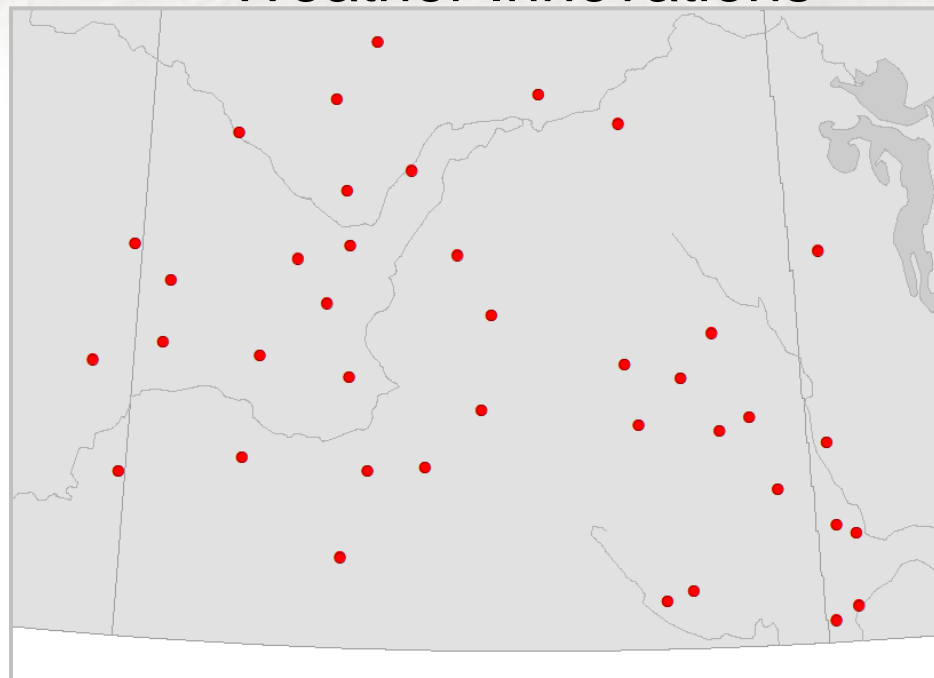


# Exploring Commercially Available Data

WeatherFarm



Weather Innovations





The Community Collaborative Rain, Hail and Snow Network is a national grassroots community based high density precipitation network across the United States, and **now Canada.**



Has your community been  
**IMPACTED BY DROUGHT?**  
Tell us by submitting a "CoCoRaHS Drought Impact Report"



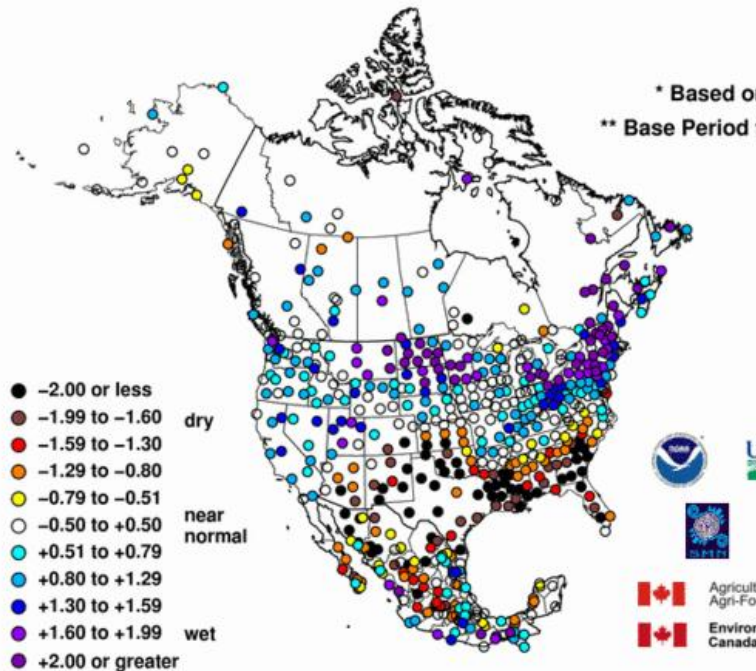
# Obvious Differences in Coverage

## 12-Month Standardized Precipitation Index

September 2010 – August 2011

\* Based on Preliminary Data

\*\* Base Period for Averages 1951–2001

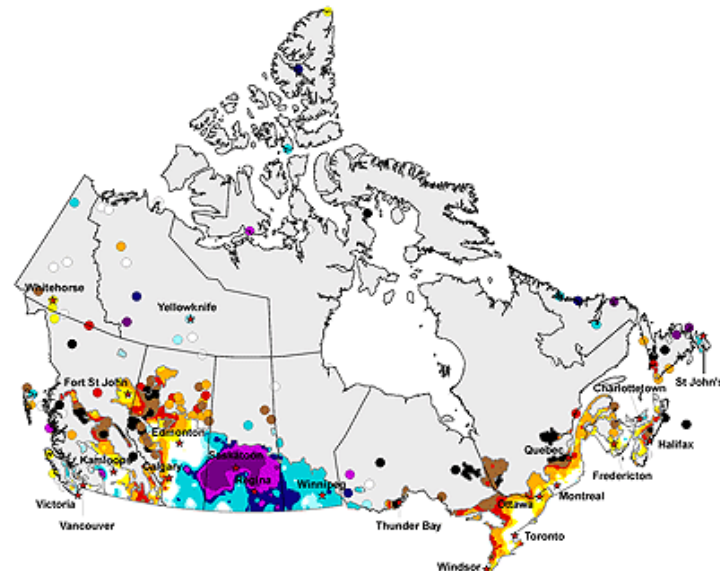


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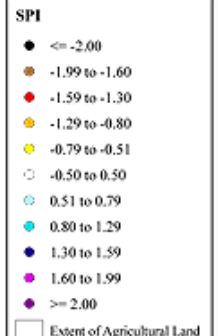
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## 12 - Month Standardized Precipitation Index (SPI)

August 2010



Canada



Produced using near real-time data that has undergone initial quality control. The map may not be accurate for all regions due to data availability and data errors.

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Prepared by Agriculture and Agri-Food Canada's National Agroclimatic Information Service (NAIS). Data is provided through partnership with Environment Canada. The original version of the NAIS Drought Model was supplied by Alberta Agriculture and Rural Development which partners with NAIS to foster ongoing development.

Created: 09/08/10  
www.agr.gc.ca/drought

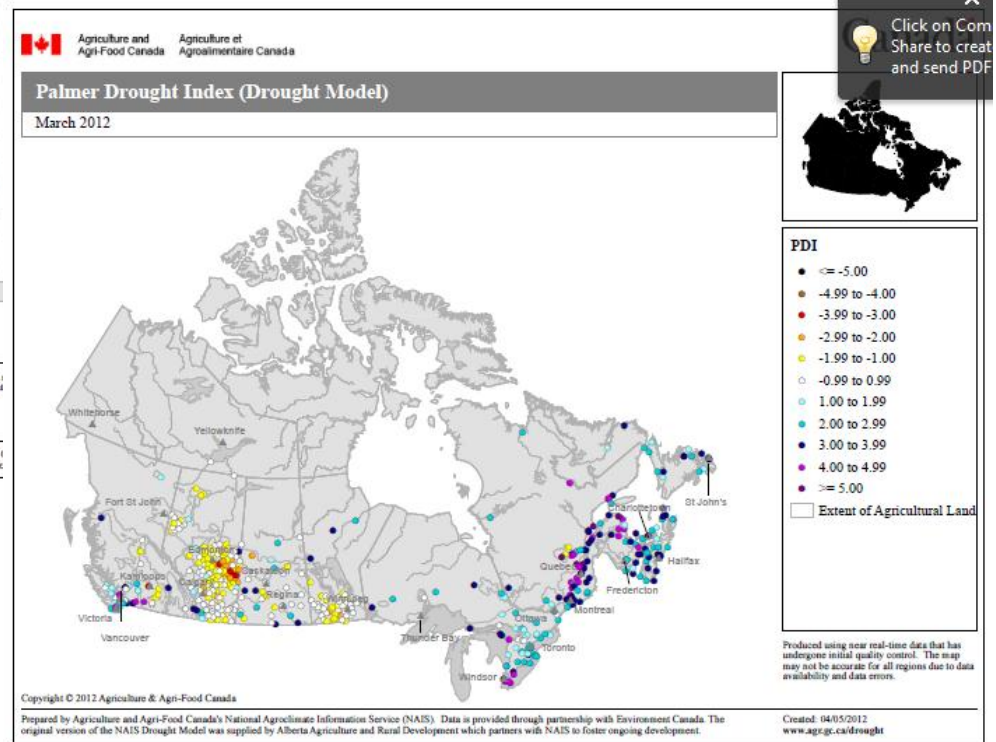
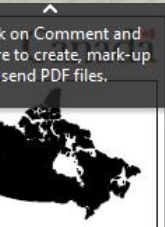
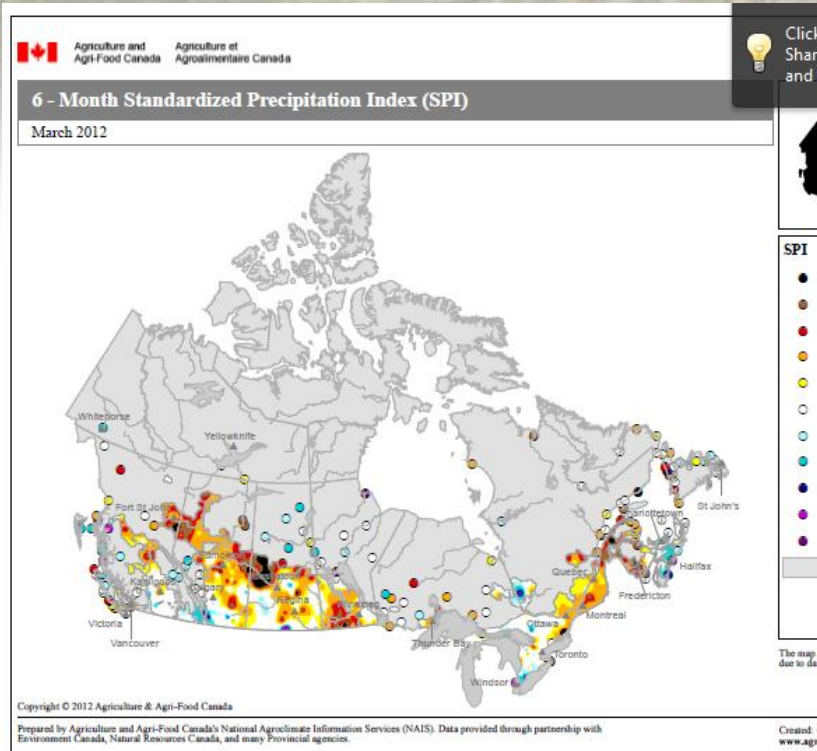


# Improve Density Without Destroying Integrity

- Gap filling must continue to be employed
  - Use data from one or more neighbour stations to assist
- Cluster approach - adjust method to create a pool of contributors for a small region (e.g. 5 to 10km radius)
- Use 10km gridded dataset to fill in a limited amount of historical information in order to keep stations alive



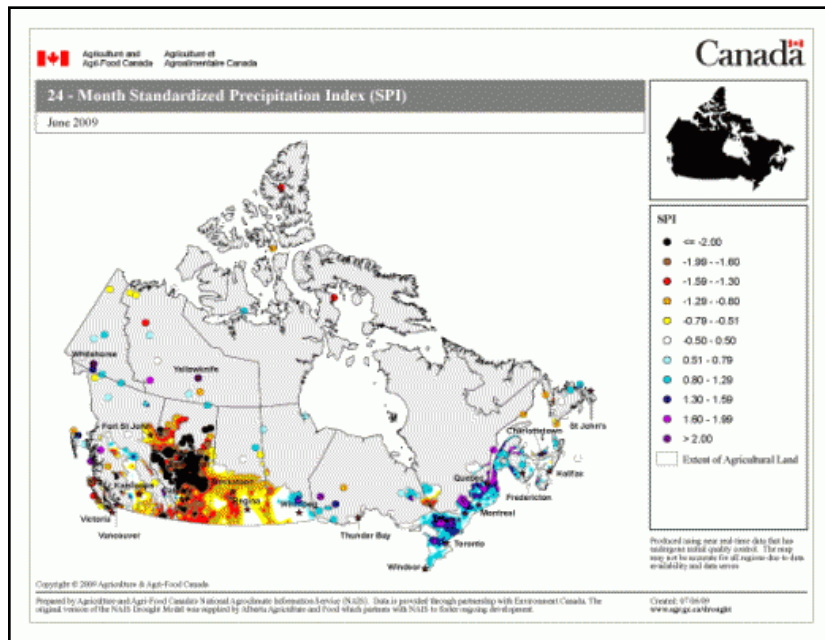
# Current SPI and PDSI Maps



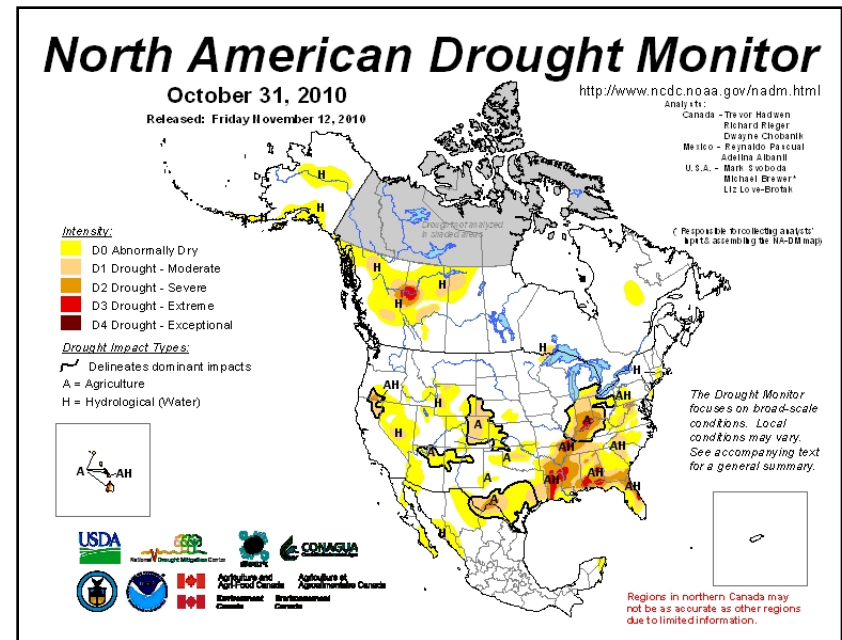


# Monitoring Outside the Agricultural Extent

## Canada's Forests are Not Well Represented in the National and International Drought Products



Drought Watch (AAFC)

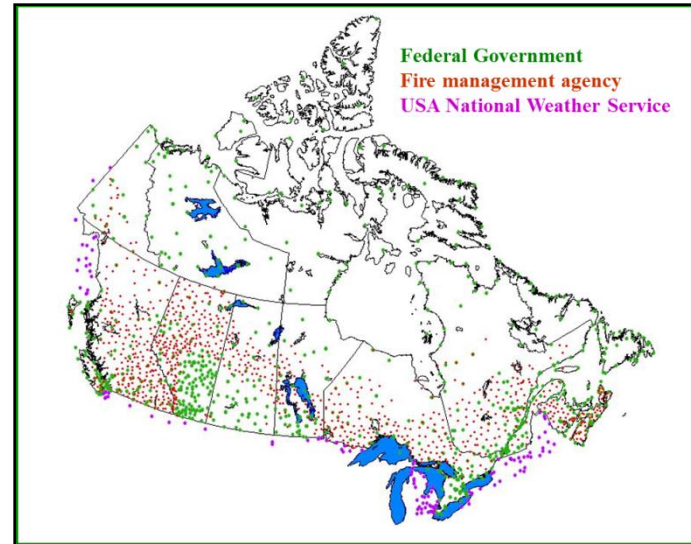
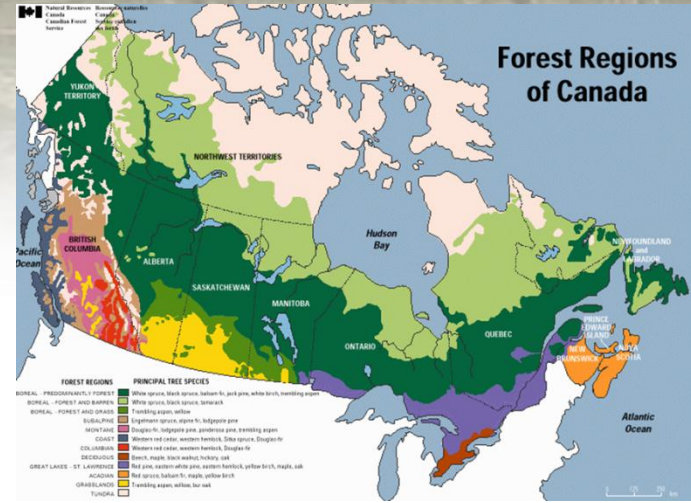


North American Drought Monitor



# Monitoring Outside the Agricultural Extent

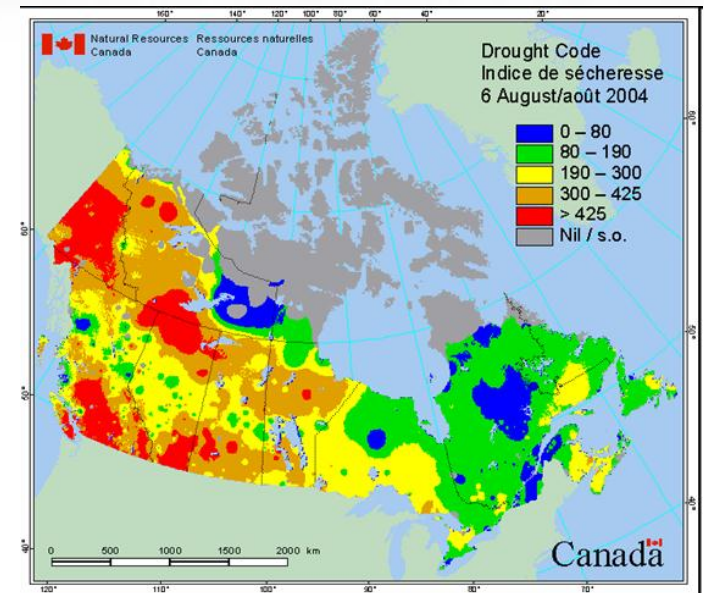
- Lack of accessible station data in northern regions.
- Lack the understanding of drought assessment and drought issues in northern areas (north of the tree line).
- Remote sensing may be able to assist in some regions.
- Research is ongoing on how to address these issues. Including the development of relative indicators for northern regions.





# Developing Indicators for Forested Regions

- The Canadian Forest Service currently uses absolute indicators for drought monitoring specifically for forest fire applications
- Relative indicators are being developed using Climate Moisture Index and the Fire Weather Drought Code (moisture deficit accounting indicator).
- Work has begun on creating a Relative indicator for the Drought Code using our percentile classes





# The Drought of 2001-2002 Impacted Forests

- Worst drought in >80 years across a large area of AB & SK
- Led to massive mortality of aspen forests
- Conifers and urban forests also affected



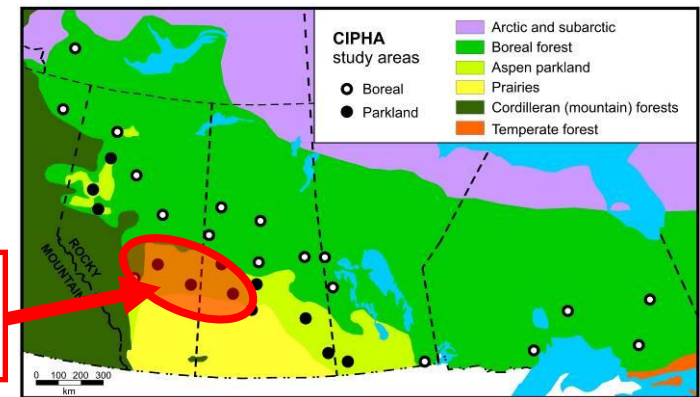
Drought-caused dieback resembling fire effects



Aerial view of mortality in the parkland (2004)



Drought-damaged aspen leaves (2002)



Drought-affected area showing severe dieback of aspen forests

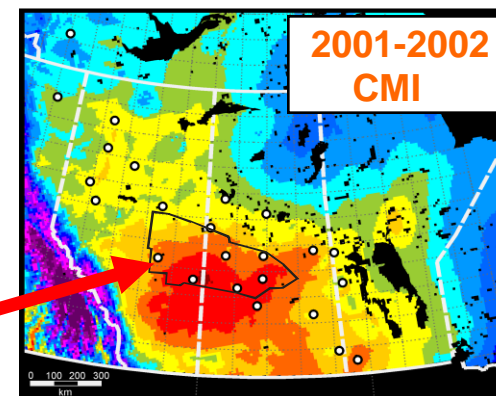
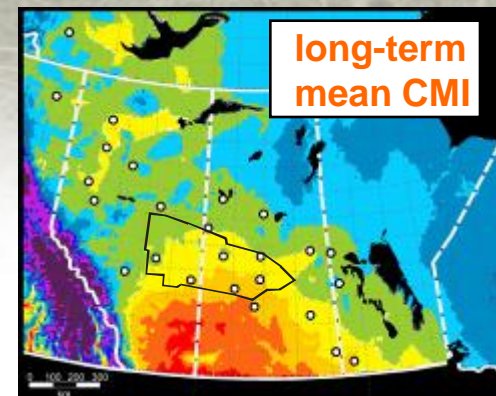
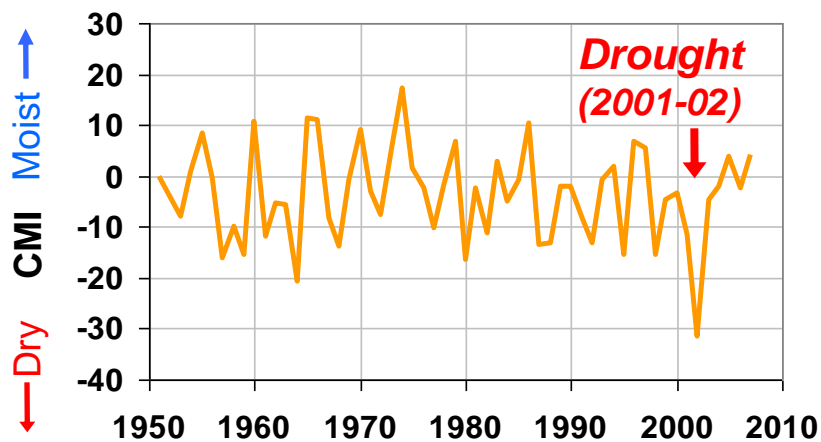


# Climate Moisture Index (CMI)

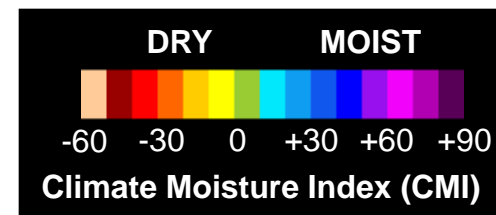
Hogg (1997) Agric. For. Meteorol. 84: 115-122

- Suitable for assessing spatial variation in annual moisture conditions relevant to forest responses. Showed severity & extent of the 2001-02 drought in the area where massive aspen mortality was recorded

Climate Moisture Index (CMI) in drought survey area



Drought  
survey  
area



ANUSPLIN interpolation of CMI by  
D.T. Price, M. Siltanen & D. McKenney



# Standardizing “absolute indicators”

Example using CMI for Edmonton

$$\text{CMI} = P - \text{PET}$$

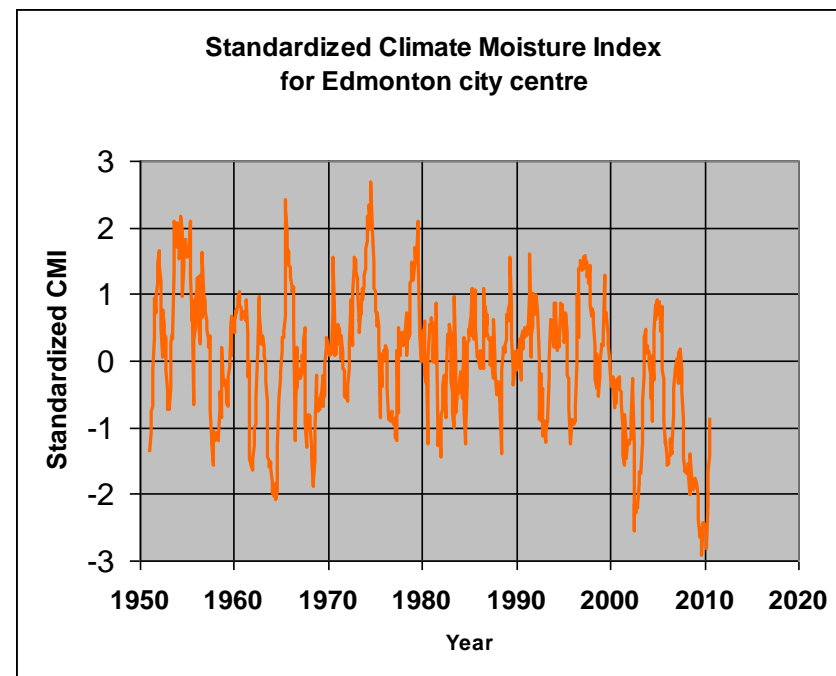
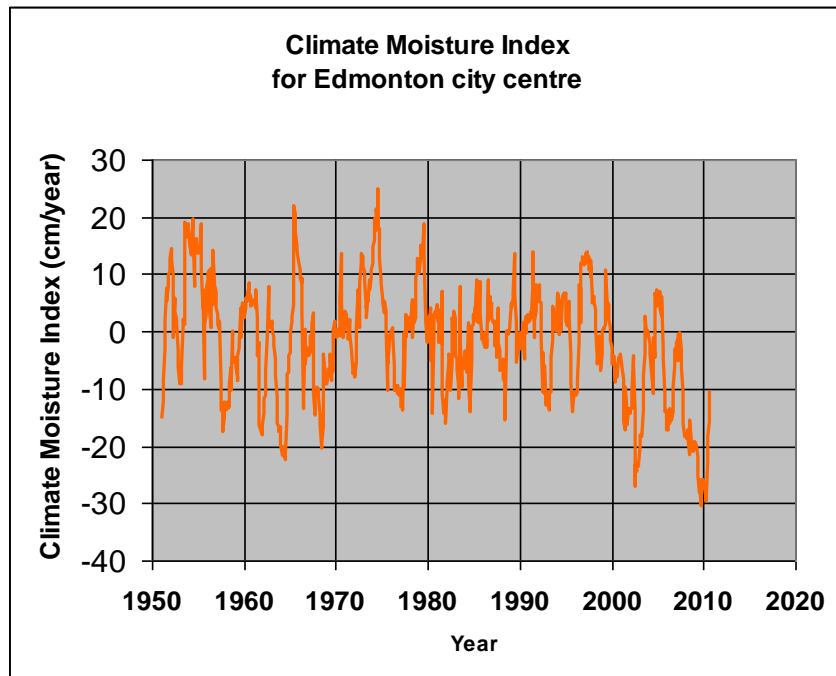
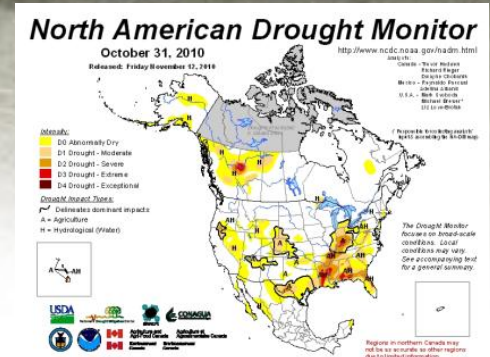
(units in cm/year)

Period: 1951-2009  
mean CMI = -1.8  
SD of CMI = 9.9

Original CMI  
(absolute indicator)

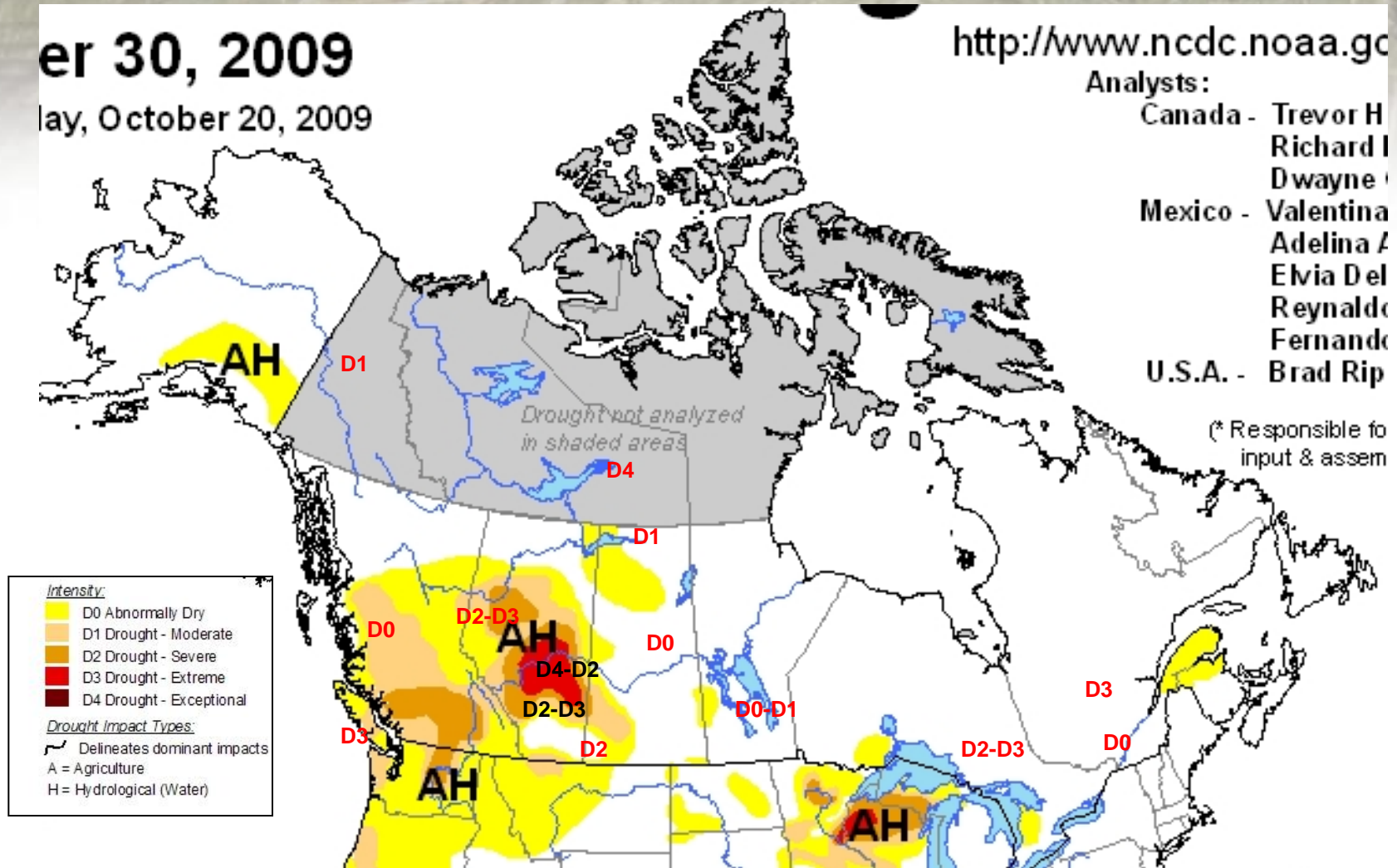


Standardized CMI  
(relative indicator)



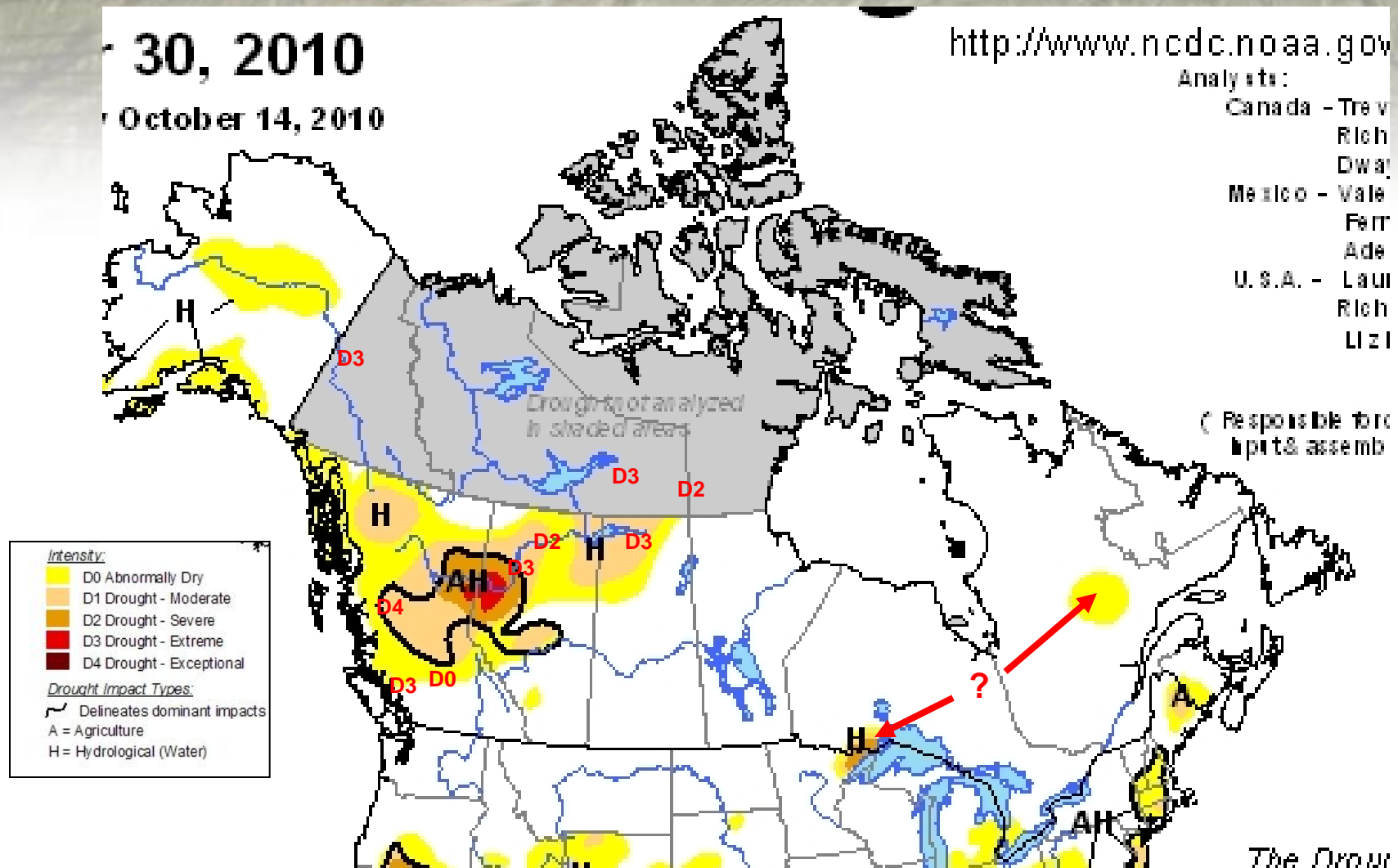


# Drought Code Example - September 30, 2009





# Drought Code Example - September 30, 2010



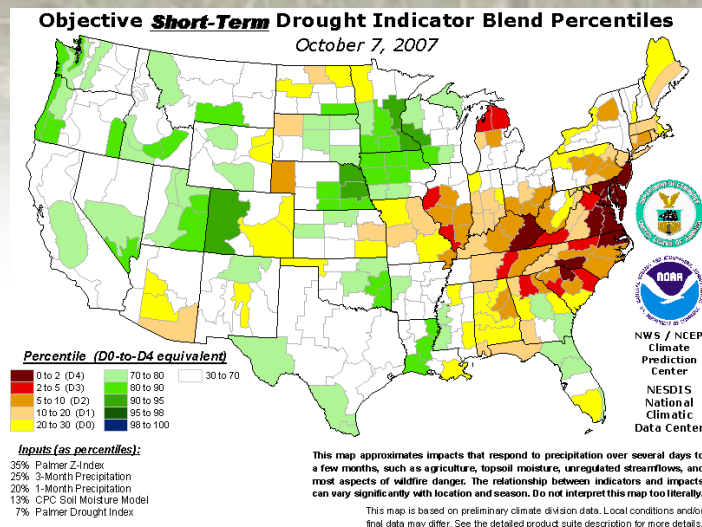


# Developing Blended Indicators

- Canada will be attempting to develop Blended Indicators.
- This will allow us to operationally Integrate multiple indicators in a weekly or monthly update using a percentile ranking method
- This is not a easy task:
  - Convert all our data types to percentiles
  - Determine the appropriate blend or more likely blends
  - Data history may be an issue. Would need serially complete data, so could not be computed on station data

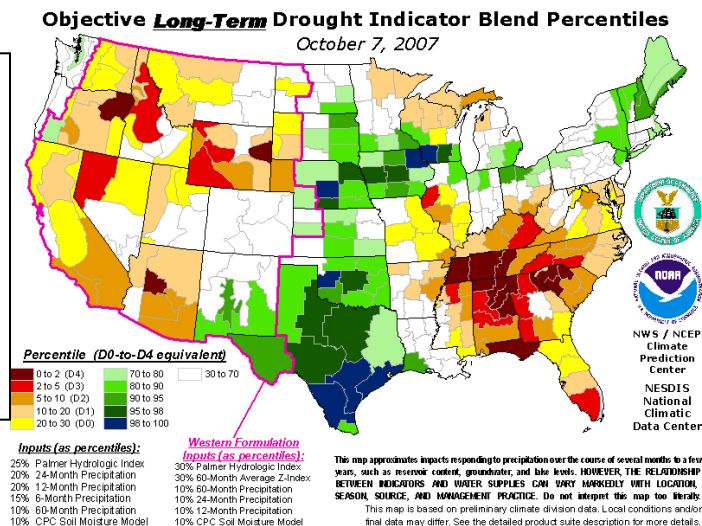
## Short-Term Blend

**35% Palmer Z Index**  
**25% 3-Month Precip.**  
**20% 1-Month Precip.**  
**13% CPC Soil Model**  
**7% Palmer Drought Index**



## Long-Term Blend

**25% Palmer Hydro. Index**  
**20% 24-Month Precip.**  
**20% 12-Month Precip.**  
**15% 6-Month Precip.**  
**10% 60-Month Precip.**  
**10% CPC Soil Model**



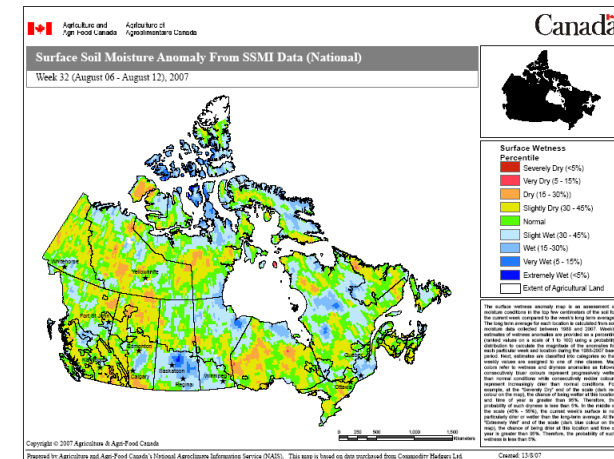


# Challenges Using Just Climate Records



- Often making drought assessments on climate data alone does represent reality, therefore we frequently use other sources of information such as remote sensing and drought impact reports.
- It is often more important to know the consequences resulting from drought than the climatic details.



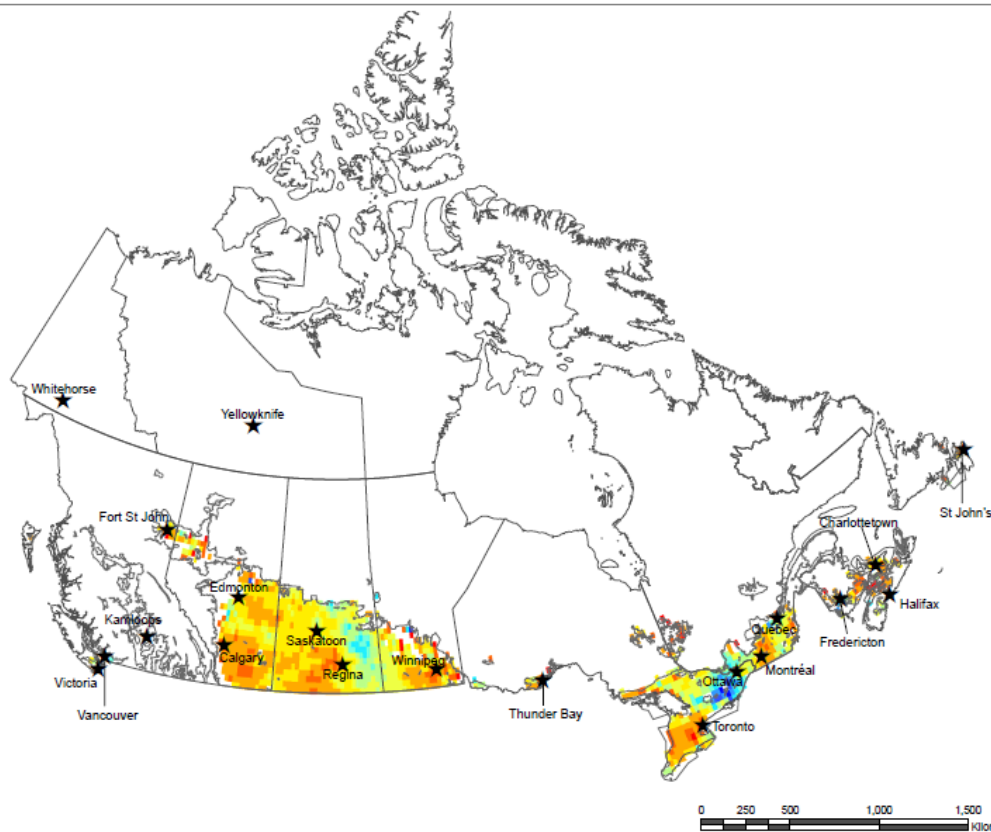




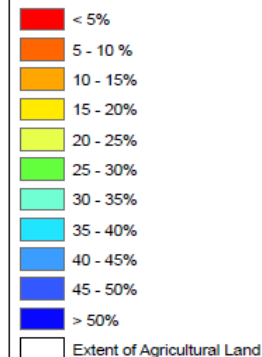
# SMOS - Weekly Satellite Soil Moisture Estimates

## SMOS Satellite Surface Soil Moisture (National)

Week 14 (April 2 - April 8), 2012



### Surface Soil Moisture



This map represents the volumetric soil moisture for the surface layer (<5 cm), averaged for the week. The map is produced from passive microwave satellite data collected by the Soil Moisture and Ocean Salinity (SMOS) satellite and converted to soil moisture using version 5 of the SMOS soil moisture processor and gridded to a resolution of 30 kilometres.

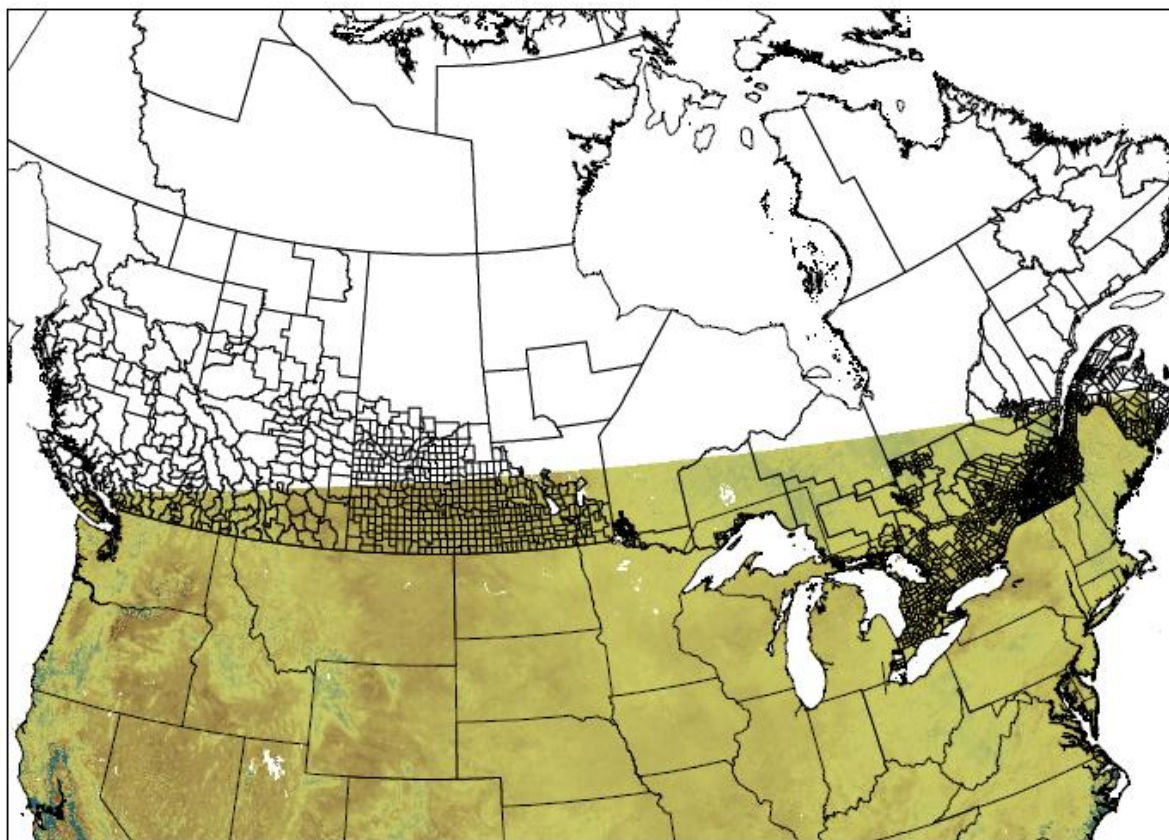
This product is still in the development phase and should be used as such.



# Potential to Expand VegDRI to Canada

Prospects of expanding VegDRI over the major agricultural regions of Canada to support Canada's monitoring ability is promising.

Canadian VegDRI Pilot Project Coverage

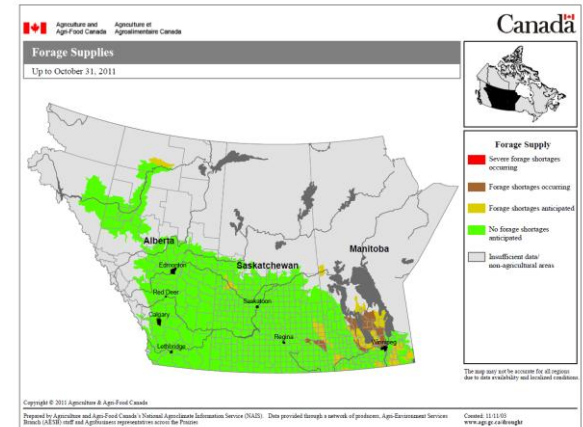
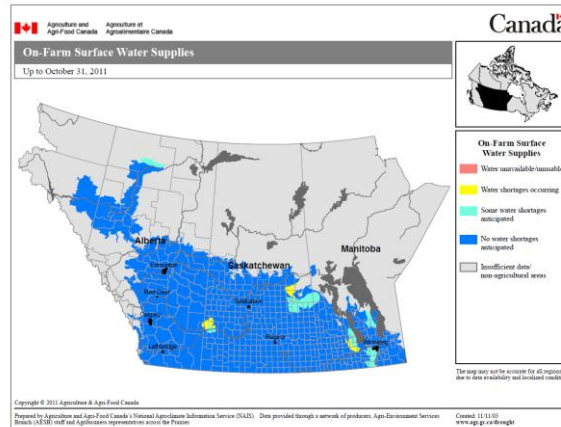
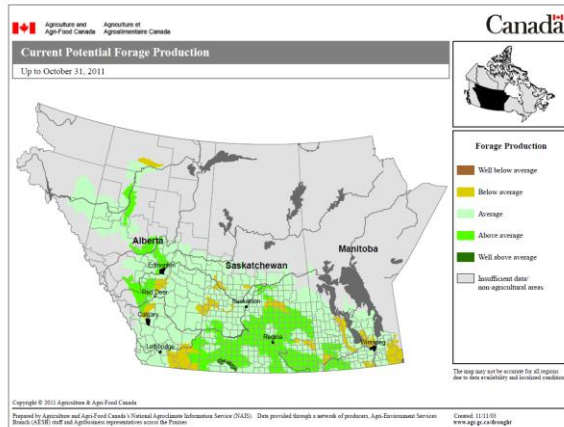


Southern Regions Of Canada Including much of the Agricultural zone is currently included in the geographic coverage of historical satellite data (AVHRR and MODIS NDVI) that has been processed by USGS.



# Assessing the Impacts of Drought

- Agriculture and Agri-Food Canada coordinates a network of approximately 350 volunteer farmers in the prairie region, who provide information on the impacts of drought and other extreme weather impacts.
- For over 10 years we have been collecting information on agricultural water supplies, forage supplies and forage productions.





# Producer Questionnaire



Agriculture and Agri-Food Canada Agriculture et Agroalimentaire Canada

## 2010 MONTHLY WATER SUPPLY AND FORAGE CONDITIONS MONITORING PRODUCER QUESTIONNAIRE

DATE:  DUID:

| Family name          | Given name           | Email                |
|----------------------|----------------------|----------------------|
| <input type="text"/> | <input type="text"/> | <input type="text"/> |

### CURRENT POTENTIAL FORAGE PRODUCTION

1. If you are experiencing weather/climate related forage losses on your farm, please indicate the major cause(s). (Check **ALL** that apply.)

- ☐ Drought
 ☐ Cool temperature/Frost  
☐ Flood/ Excess moisture
 ☐ Hail  
☐ Heat stress
 ☐ Other

2. How does the forage production in your area, at this time of year, compare to the 10 year average?

- ☐ Well below average (less than 50%)  
☐ Below average (50 to 90%)  
☐ Average (90 to 110%)  
☐ Above average (110 to 150%)  
☐ Well above average (greater than 150%)

3. What is the condition of the pasture (tame/native) in your area?

- ☐ Poor  
☐ Fair  
☐ Good  
☐ Excellent

### FORAGE SUPPLIES

1. Do you anticipate any forage shortages in your area?

- ☐ Severe forage shortages occurring  
☐ Forage shortages occurring  
☐ Forage shortages anticipated  
☐ No forage shortages anticipated

2. In general, how would you rate the price of hay (tame/native) in your area?

- ☐ Below average  
☐ Average  
☐ Above average

3. If known, what would you estimate the price to be? (Please specify the measure provided.)

### ON-FARM SURFACE WATER SUPPLIES

1. What is the average level of the dugouts in your area?

- ☐ Unusable/Dry  
☐ 1/4 full  
☐ 1/2 full  
☐ 3/4 full  
☐ Full

2. Do you anticipate any water shortages for your area?

- ☐ Water unavailable/Unusable  
☐ Water shortages occurring  
☐ Water shortages anticipated  
☐ No water shortages anticipated

### EXCESS MOISTURE

1. To what degree has the recent flooding/excessive moisture conditions impacted animal health in your region?

- ☐ Severe  
☐ Moderate  
☐ Low  
☐ None

a) If you calved late, are wet conditions creating increased incidence of calf scours?

- ☐ Yes  
☐ No

If you answered "YES", what is the percentage of increase?

- ☐ Greater than 75%  
☐ 50 to 75%  
☐ 25 to 50%  
☐ Less than 25%

b) Are wet pasture conditions resulting in increased levels of foot rot?

- ☐ Yes  
☐ No

If you answered "YES", what is the percentage of increase?

- ☐ Greater than 75%  
☐ 50 to 75%  
☐ 25 to 50%  
☐ Less than 25%

2. To what degree has the recent flooding/excess moisture impacted local transportation (roads/rails)?

- ☐ Severe  
☐ Moderate  
☐ Low  
☐ None

a) Are soft grid roads restricting the hauling of heavy loads - cattle trailers, hay/forage?

- ☐ Yes  
☐ No

3. Have wet pasture conditions forced you to re-locate cattle to different drier pastures?

- ☐ Yes  
☐ No

4. Please comment on any significant damage the recent storms and excessive moisture may have caused. (Soil erosion, infrastructure damage (please be specific), well contamination, wash out, etc.)

5. What is your best estimate as to the percentage of unseeded acres in your region?  %

6. What is your best estimate as to the percentage of seeded but now flooded acres in your region?  %



# Agroclimate Impact Monitoring

We are currently:

- Transitioning to a new resource framework
- Developing a new online data collection tool (Agroclimate Impact Reporter)
- Increasing the density of the volunteer network
- Expanding the geographical scope of the program (Including B.C. in 2012)
- Increasing the value of the information collected.



## Prairie On-Farm Surface Water Supply and Forage Conditions Monitoring Program

### 2009 Seasonal Review

Released: December 31, 2009

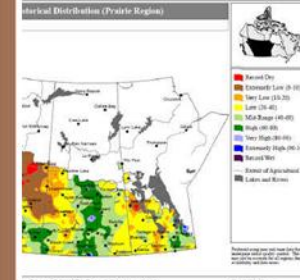
#### Overview

This Agriculture and Agri-Food Canada (AAFC) report is produced by AAFC's Agri-Environment Services Branch (AESB). The information in this report – compiled by AESB's National Agroclimate Information Service – was obtained from approximately 400 producers and industry representatives throughout the Prairie region who report on water supply and forage issues on a monthly basis during the growing season.

#### 2009 Extended Growing Season

season (April 1-October 31) can be summarized in one short statement, or data normal temperatures throughout the season, and record low pre-April through June resulted in poor growing conditions. As noted in the regions of northern and central Alberta and western Saskatchewan were often over this past year. In contrast to drought conditions in the west, a dearth with excess moisture.

#### 2009 Percentile Map



Canada

precipitation was classified as 'Extremely Low' or 'Record Dry' across central Alberta and west-central Saskatchewan (Map 2). Much of Alberta and Saskatchewan received below normal precipitation, with the exception of southern areas of Saskatchewan.

The winter of 2008/09 brought cooler than normal temperatures and below normal snowfall amounts across much of the Prairies. Central and southern regions of Alberta and Saskatchewan received less than 60% of normal precipitation, further reducing potential spring soil moisture. Many of these regions had minimal snow cover, including areas east of Edmonton, where the ground was bare even

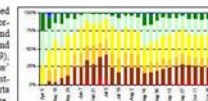
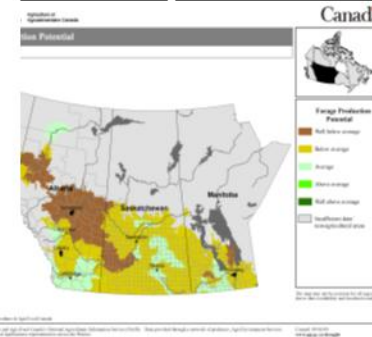
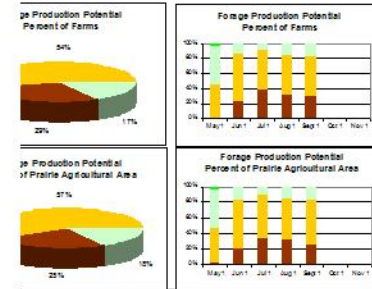


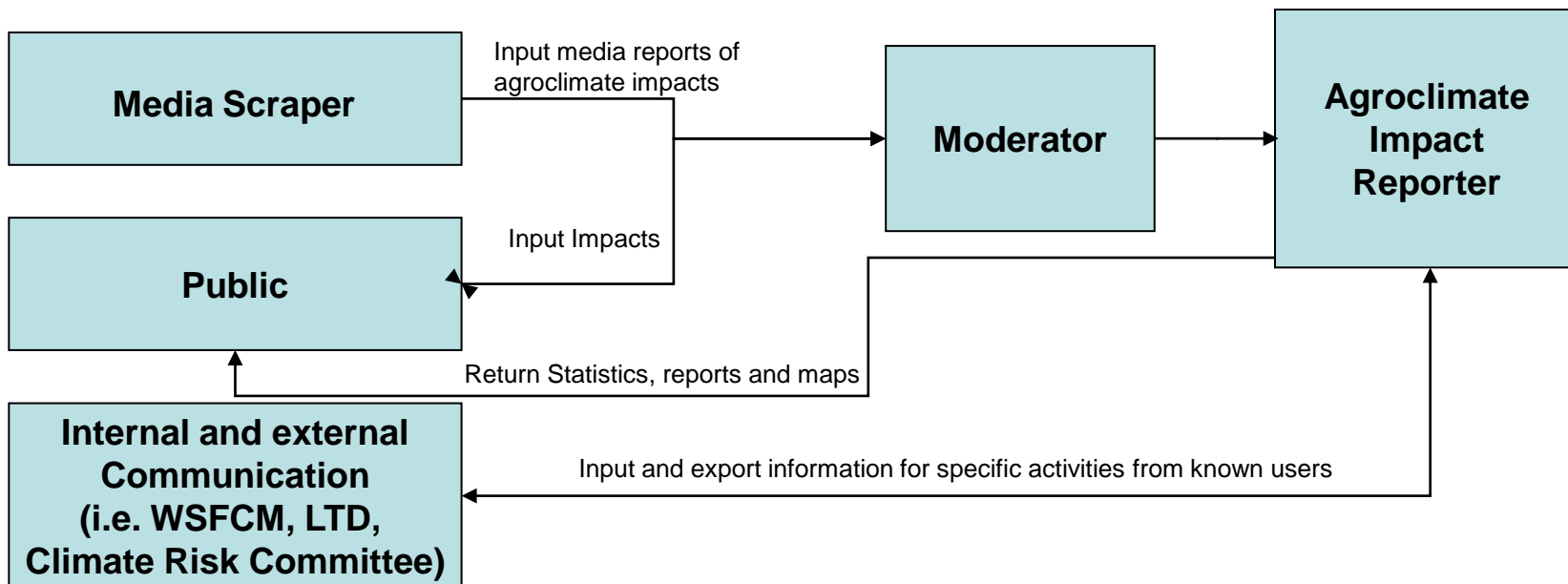
Figure 1 - Precipitation Compared to Historical Distribution: % of Agricultural Area (Seasonal Trends)





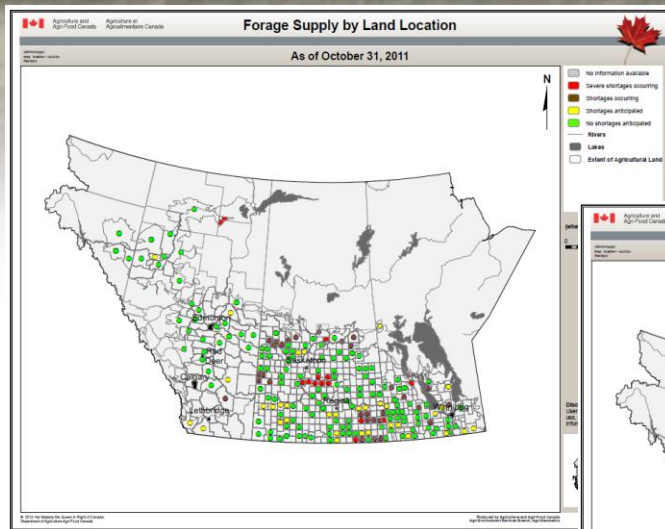
# The Agroclimate Impact Reporter

- The Agroclimate Impact Reporter is being developed in response to the need for a **National Agroclimate Impacts Database** and a tool to collect, manage and display various forms impacts of climate on the agricultural systems throughout Canada.
- The Impact Reporter will provide the ability to collect information from anonymous sources as well as registered users for the assessment of drought, floods and other climate related impacts.

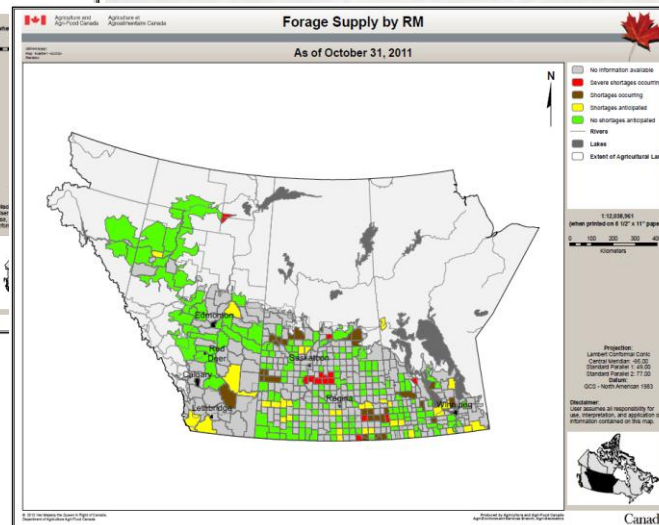




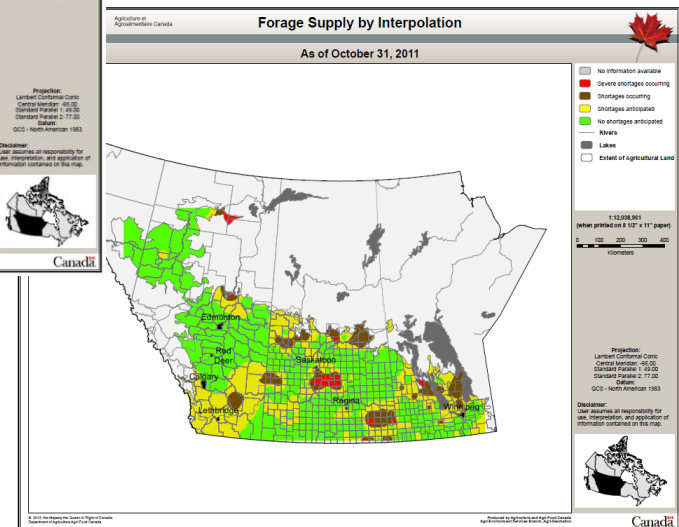
# Examples of Output from the AIR System



Point values



Point values used to  
classify Municipalities



Interpolated to provide  
a complete coverage



# Summary

- Canada has made significant steps in developing tools to advance the monitoring drought.
- Increasing the data networks, adjusting the data models, developing indices for northern regions, and increasing the collection of impact information will significantly improve our ability to accurately assess and analyze drought.
- Increasing the profile of the Canadian Drought Monitor has begun to increase partnership and interest in the product. This will only increase the accuracy of the assessments Canada provides to the NADM.





# Thank You



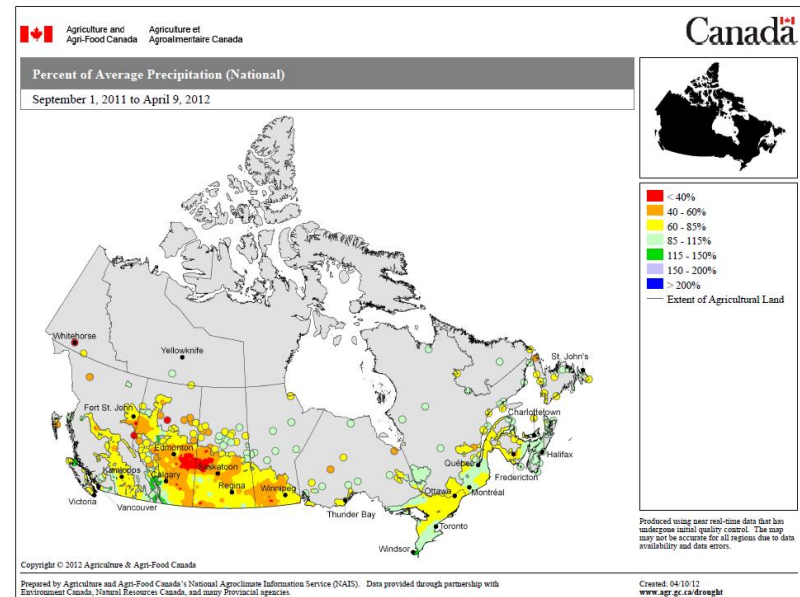
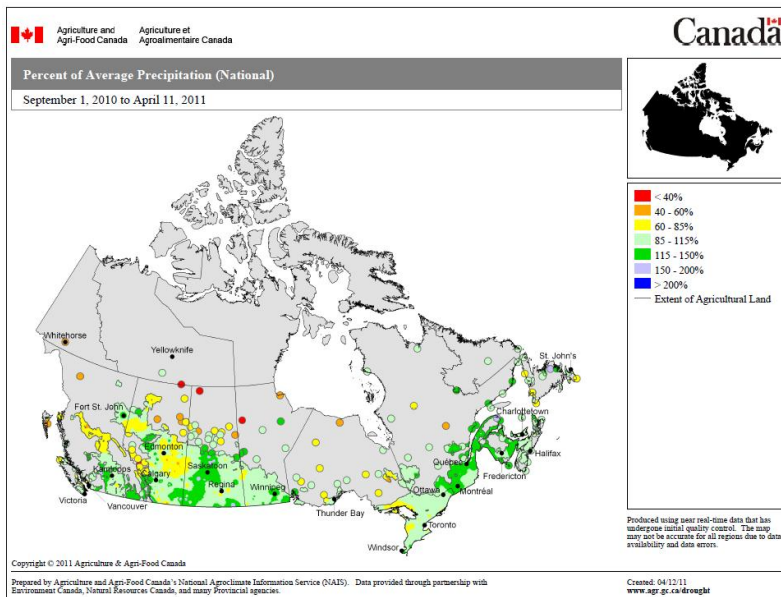
Trevor Hadwen  
Agriculture & Agri-Food Canada  
(306) 780-8405  
[trevor.hadwen@agr.gc.ca](mailto:trevor.hadwen@agr.gc.ca)

# Canada



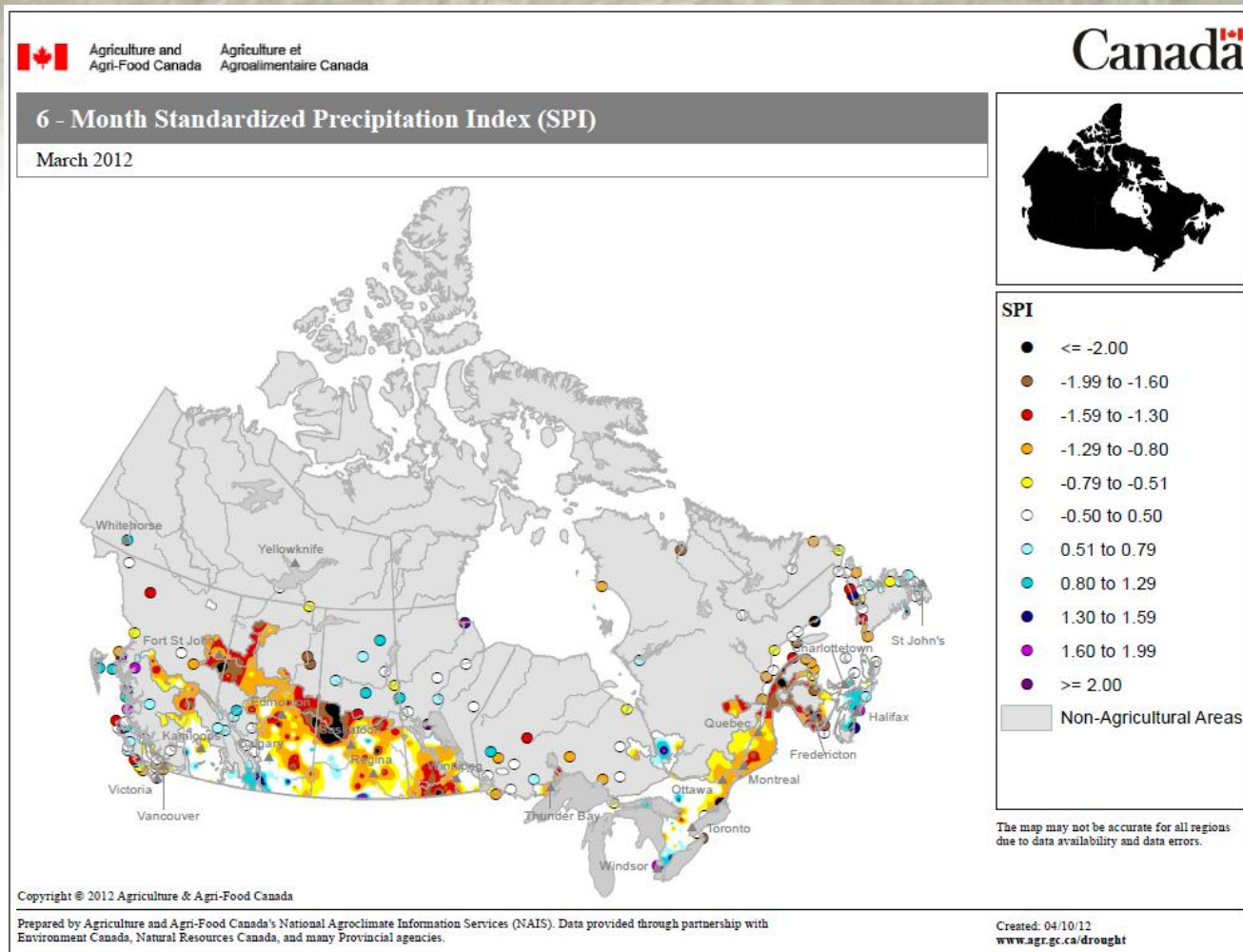
# What a difference a year makes...

- One year ago, the Canada was dealing with unprecedented flooding, after record snow fall and spring rain.
- This year we have had one of the dries and warmest winters on record and there is great concern for drought.





# 6 Month SPI





# Palmer Drought Index



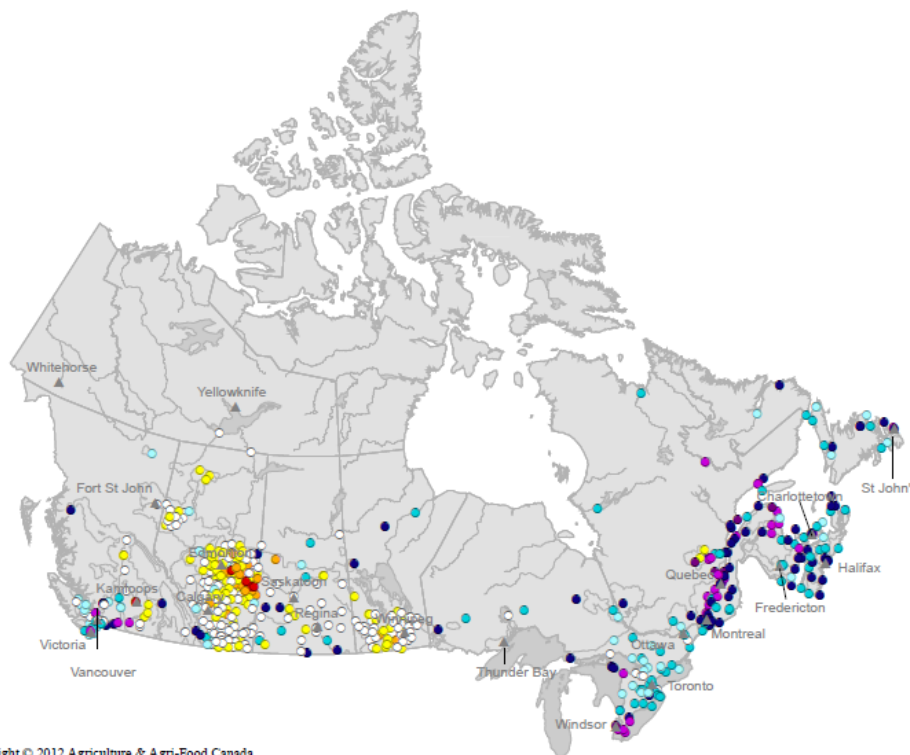
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Agroalimentaire Canada

Canada

## Palmer Drought Index (Drought Model)

March 2012



### PDI

- $\leq -5.00$
- -4.99 to -4.00
- -3.99 to -3.00
- -2.99 to -2.00
- -1.99 to -1.00
- -0.99 to 0.99
- 1.00 to 1.99
- 2.00 to 2.99
- 3.00 to 3.99
- 4.00 to 4.99
- $\geq 5.00$

□ Extent of Agricultural Land

Produced using near real-time data that has undergone initial quality control. The map may not be accurate for all regions due to data availability and data errors.

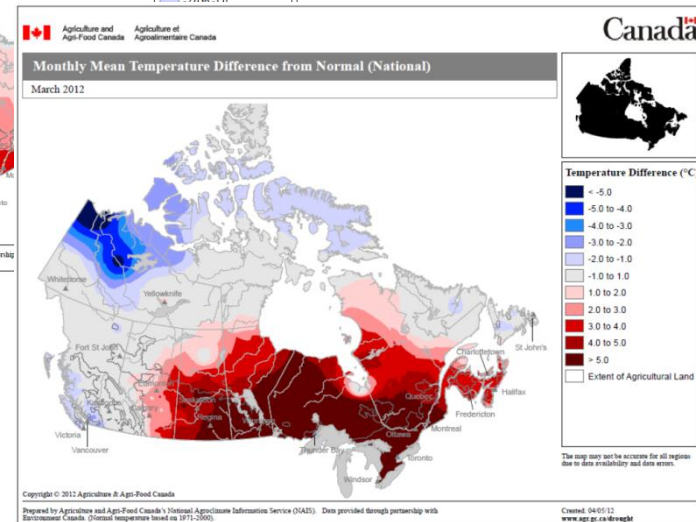
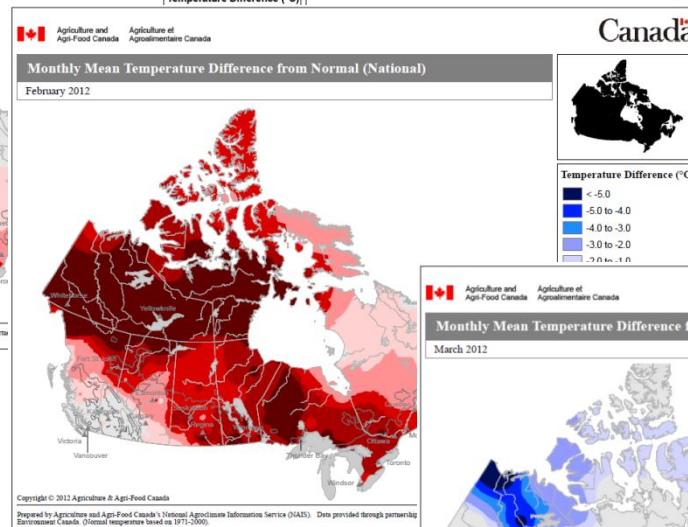
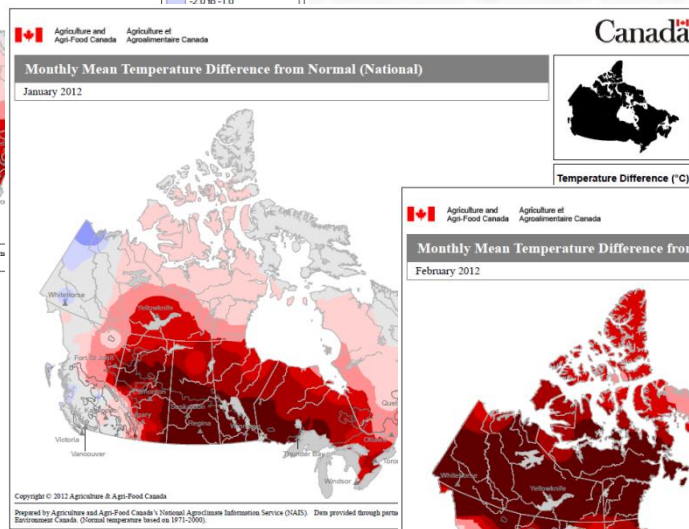
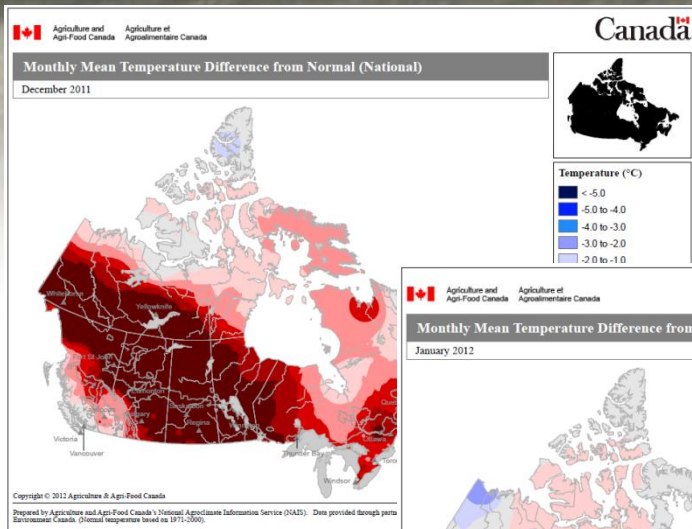
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Prepared by Agriculture and Agri-Food Canada's National Agroclimate Information Service (NAIS). Data is provided through partnership with Environment Canada. The original version of the NAIS Drought Model was supplied by Alberta Agriculture and Rural Development which partners with NAIS to foster ongoing development.

Created: 04/05/2012  
[www.agr.gc.ca/drought](http://www.agr.gc.ca/drought)



# Monthly Temperature Anomalies

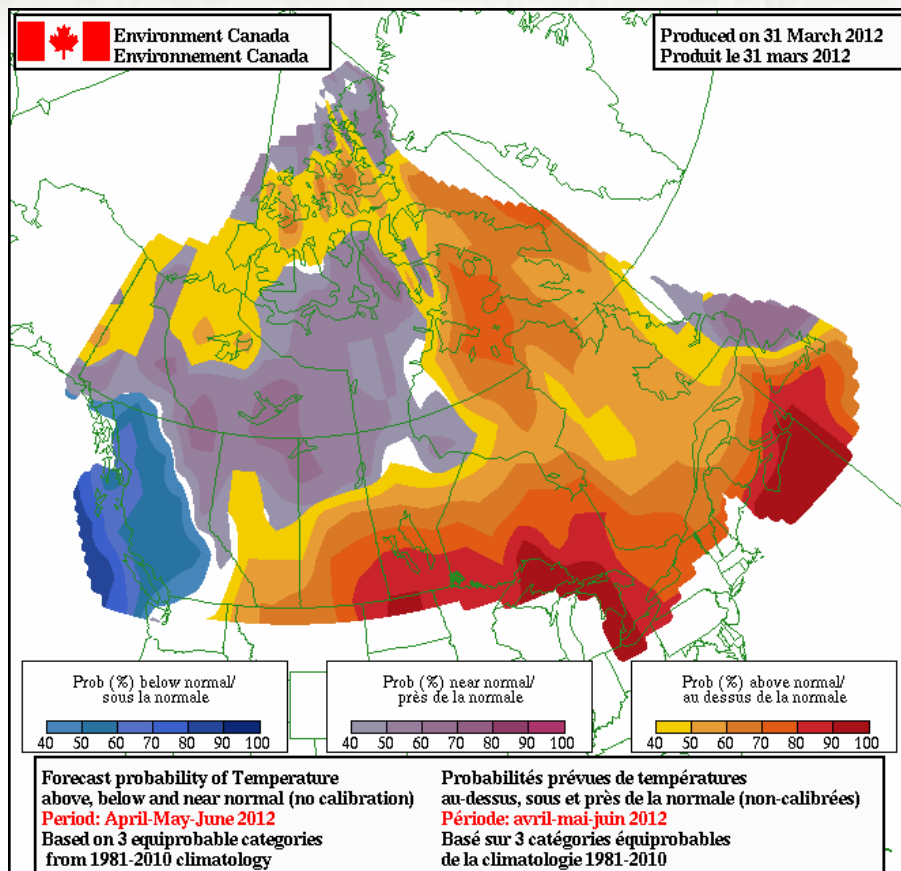


Much of Canada has been consistently 5 degrees warmer than normal for the past 4 months.



# Long Range Forecasts

## 3 Month Temperature Forecast



## 1 Month Precipitation Forecast

